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OXC-5741
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30 September 1963

MEMORANDUM FOR: Deputy for Technology, OSA

SUBJECT : Westinghouse Progress Report - 1 August 1963 - 31 August 1963

Attached for your information and file are two (2) copies of Subject report.

[redacted] 25X1

Chief, Contracts Division, OSA

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WESTINGHOUSE ELECTRIC CORPORATION

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September 26, 1963

Advanced Plans & Programs Division (ASZ-5)
Deputy for Systems Management
Hq. Aeronautical Systems Division
Wright-Patterson Air Force Base, Ohio

A18869T

Subject: Contract AF 33(600)40280; Submission of Progress Report for August 1963; Westinghouse Reference DYD-45196.

Enclosure (1): Three (3) copies of Progress Report for the period of August 1, 1963 to August 31, 1963.

Gentlemen:

In accordance with the subject contract, we are enclosing the monthly Progress Report for August.

Very truly yours,

WESTINGHOUSE ELECTRIC CORPORATION

[redacted] 25X1

Marketing Specialist
Marketing Department

RWE:sk
Encl.

CC: [redacted] (with one copy of Enclosure) 25X1

IF ENCLOSURES ARE WITHDRAWN (OR NOT ATTACHED), THE CLASSIFICATION OF THIS CORRESPONDENCE WILL BE CANCELLED IN ACCORDANCE WITH PAR 25E AF REGULATION 205-1 OR NAVY REGULATION ARTICLE 76 (5) (11).

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SECRET PROGRESS REPORT

Period of August 1 to August 31, 1963

Contract No. AF33(600)40280

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A FLIGHT TEST PROGRAM

FILM EVALUATION

No flights were made and no work was performed in film evaluation during this reporting period.

INSTRUMENTATION

No new instrumentation recordings were produced this month. However, circuit modifications have been completed to accomodate the new CFA transmitter and to increase the magnetic tape recording capabilities from 7 to 14 channels. Approximately 80% of recalibration has been completed.

The following is a list of signals currently recorded on an oscillograph recorder:

1. Antenna valve drive
2. Mode switches
3. Positive power supplies
4. Negative power supplies
5. Data flash
6. Stable table position
7. VFO position
8. DFT offset
9. 18KV CFA power supply
10. CFA current
11. Antenna position
12. Missile bay temperature
13. XMTR vessel temperature
14. CFA chassis temperature
15. TWT collector temperature
16. CFA tube temperature

SYSTEM

Modifications to accept the new transmitter and retrofitted system components have been completed. Delays were encountered in achieving satisfactory transmitter operation due to component failures. The most troublesome component has been high voltage break-down of the charging choke inthe CFA transmitter. The reason for this breakdown is being investigated and, in the meantime, the transmitter was modified to physically operate with

either an open construction choke or an oil filled choke.

The transmitter has progressed to the point where it is usable, although hardly operational. The items requiring further work are low power output and non-correlated TWT and CFA pulse operation.

Improved recorder #5 was installed this month. Specific improvements include lighter construction, a better resolution CRT, better temperature stabilized circuitry, and incorporation of cassettes which allow film changes to be made in light exposed areas.

Loading of the new DFT by instrumentation was eliminated by installing an emitter follower in the DFT output. The DFT was also modified to provide signal threshold switching to the antenna servo. This switching is so mechanized to provide the "Rate Gyro Only" mode of servo operation whenever signal is lost (over water for example).

The antenna pod actuator and pod servo shut-off valve developed leaks and were repaired. The antenna pod servo operates satisfactorily.

B <u>ENVIRONMENTAL TEST PROGRAM</u>

Vibration tests were performed on the modified TWT assembly in the yaw axis direction. During vibration, the tube was electrically energized and the noise figure monitored. Acceleration levels were measured directly on the tube case. Severe resonances of the tube were measured in the 55 to 75 cps range with a maximum amplification of 7:1 with an input of about 1.5 g. No significant change in noise level was noted over this range. Maximum acceleration

for which the tube is designed is 5 g. Because of the severity of the resonances, the TWT chassis was redesigned and additional vibration tests were performed. To expedite this evaluation, testing was performed on the TWT assembly in the pitch axis direction. Tube resonance was noted at about 170 cps with an amplification of 7:1 with an input acceleration of about 1.4 g. Further modifications to the TWT Chassis are to be accomplished prior to additional vibration testing.

Vibration tests were performed on the antenna in directions parallel to the radiating sticks, referred to as the pitch axis, and perpendicular to the radiating surface or yaw axis. The purpose of the test is to measure relative motion of points along the antenna. From this data it can be determined if electrical degradation will result. To accomplish this purpose, accelerometers were attached to the antenna and oscillograph recordings made of the vibration levels. In the pitch axis resonances were recorded at 23, 36 and 84 cps on the ends of the barriers and sticks. In some cases amplifications of greater then 10:1 were measured. In the yaw axis resonances were recorded at 23, 36, 160 and 435 cps along the structural beam. Amplifications of greater than 20:1 were measured at the antenna span center and the overhang end.

C DESIGN EVALUATION PROGRAM

The studies listed below were completed and memos written during this period.

1. Radar Range Equation and Signal/Noise Theory (STM-129).
2. System Signal/Noise Performance Calculations (STM-132).

In connection with the first of these, further tests were run on the ability of an observer to detect changes in film density in the presence of a noise background, and for separated regions, similar to those described in last month's report. Whereas only one observer was used on the first test, seven observers participated on this test, run by an additional unbiased person. The results obtained were somewhat different, but similar, to those of the first test, and the STM was modified to make use of these results. The conclusion was that approximately 0 db S/N is required for detection of separated regions, whereas about -6 db will enable detection of adjacent regions. These values, however, depend markedly on the map film operating point.

The other study underway during this period was the effect of a Taylor-weighting semi-transparent mark in the frequency plane of the correlator. Curves were derived showing:

a. The signal variation across the map strip

b. S/N ratio across the strip, for various doppler errors

c. Reduction in effective offset frequency

d. Improvement in signal/clutter ratio

The next problem is to find the effect on correlation side-lobes, for various offset frequencies displaced from the mask center. This is a very difficult problem, and it appears that it will have to be solved on a digital computer.

During the next period, work on the mask filter will be continued, and study of possible improvements for a new generation system will be started.

D ANTENNA

The No. 2 antenna will be retested to determine the usable span of frequencies about the center frequency, the boresight location and the shift of boresight with changes of frequencies.

No. 3 antenna is undergoing exploratory vibration tests to determine its vibration characteristics. Preliminary analysis of the data indicates that some improvement of characteristics will be gained by padding the power dividers and devising more rigid clamps. Thermal RF tests of No. 3 antenna are being prepared to start on completion of the vibration tests. Five of the six spares modules have been assembled, soldered, electrical tested and are ready for electroforming. The sixth module has one stick that must be rebonded and soldered.

The wooden mock-up of the antenna is being reworked to provide a very close duplicate of the antenna for use in determination of clearances.

E RECORDER

GENERAL

At a review meeting Westinghouse and Itek personnel discussed the recorder delivery schedule as it effects the system schedule. It was decided that recorder No. 6 would be returned to Itek for rework immediately upon shipment of No. 5. Recorder No. 6 would then be reworked during September to be identical with No. 5.

Review of the design evaluation specifications indicated some changes were necessary. These are being incorporated into the specification by Westinghouse.

Acceptance test was conducted for recorder No. 5 and the unit delivered to Westinghouse. Recorder #6 was returned to Itek from Westinghouse for updating. Assembly of recorder #7 is continuing on schedule. The critical items are the Wollensak lenses, scheduled for delivery on September 26.

CIRCUIT IMPROVEMENTS

Modifications of the electronic package circuitry were completed during the report period. The germanium 2N1552 transistors used in the output switching of both the triangular and step deflection circuits were replaced with MHT1611 silicon transistors. The germanium transistors have a rise, storage and fall time measured in microseconds compared to nanoseconds for the silicon transistors. The major delay now remaining is approximately two microseconds due to the transformer which drives the bases of the output transistors. Work to improve this delay continues.

Specifications for the trace alighment were derived, calling for a point 166 microseconds from the beginning of the 4 kc pulse to be located optically at the center of the trace with a writing speed of 12.23 microseconds per inch. The writing speed at present is limited to a minimum of 14 microseconds per inch. An attempt to increase the voltage applied to the output stage and increase the speed failed because of overvoltage of the electrolytic capacitors. Two alternatives are available. Either the yoke inductance can be reduced with some loss of linearity or capacitors and transistors with high voltage rating can be obtained to operate at the voltage required by the present yoke. The latter will require more space than is presently within the electronic package.

The new focus modulation circuit was installed in the electronic package for recorder No. 5 with excellent results.

The additional load created by the change to a 6U8 tube in the focus modulation circuit overloaded the rectifiers in the regulated filament supply. The rectifiers have been changed from one ampere units to a 1N1613 type which is rated at five amperes and a PIV of 100 volts.

HIGH VOLTAGE POWER SUPPLIES

Kaiser High Voltage Power Supply #9761 performed very well in recorder No. 5 during the entire Acceptance test and was shipped with the recorder. Some problems evident prior to the Acceptance test were solved. The ultor voltage output of 15,170 volts plus focus modulation voltages of 150 volts peak to peak requires focus output voltages in the order of 4200 volts. Modification of the voltage input to the focus regulator circuit was required to obtain the correct focus voltage.

The synchronization of the free running oscillator to the external square wave drive is sensitive to changes in the 28.0 volt supply. It is recommended that the 28 volt input be set to 27.5 volts (measured at the input terminal to the Kaiser Supply) for best locking conditions.

The supply appears to hold the requisite ultor voltage to focus voltage ratio very well once it is established after the proper warm-up interval. During this dynamic test period, the supply was put through a large number of on-off cycles, and did not fail under this extreme operating condition.

Kaiser High Voltage Power Supply #9889 failed during the Phase II portion of the Acceptance test. A high voltage rectifier stack failed and has been replaced. This unit is undergoing tests to determine the cause for the poor line regulation of the focus supply.

TESTS

Vibration testing of recorder No. 5 using a loudspeaker input was temporarily discontinued when it became evident that the speaker used had resonant peaks that were transmitted to the recorder.

A film run test was made with thin base film. When switching from thick base (.0055") film to thin base (.0031") it is necessary to change an aluminum drive roller to rubber and adjust clearance on the viscous drag roller. The torque setting of the supply and take-up spools and the opposing torque or drag of the viscous roller need not be disturbed.

After the recorder was updated with the shear-type mounts and optically realigned, film tests were made and evaluated. Significant improvements resulted from the cork-rubber placed in the film transport system and the optical system (M3 mirror and lens). The Acceptance test of No. 5 followed at this point.

In a continuing effort to reduce the effects of vibration, a design for a non-adjustable M3 mirror mount will be started in September. Focusing adjustments will still be available but rotational motions will not.

SWEEP POSITION INDICATOR

The design of a microscope position indicator was started

to facilitate measurement of CRT sweep speed. The indicator will consist of a scale attached to the microscope bracket and a reticle and viewing lens which is attached to the microscope and moves laterally with it. Design and fabrication of this assembly should be complete in September.

F SWITCH TUBES

The WX-3846-16 tail bite tube has been fabricated, tested, and packaged.

Testing on the traveling-wave resonant ring is complete on three of the four WX-4554 dump tubes fabricated. The results show that the peak power gain out the antenna arm of the ring ranges between +3.2db to +4.5db above the reference input arm signal. The isolation of the tubes was 14 db to 20 db. The breakdown times range between 2 nsec to 4 nsec at the -3 db point. The fired pulse-width was 10 nsec or less at the -3 db point. The tubes which had a phase shift unfired to fired state closer $\frac{\lambda g}{4}$ showed the higher peak power gains.

Tube S.E.I. 307-4 was also tested on the traveling-wave resonant ring. The results show that the isolation, breakdown time to the -3 db point and the fired pulsewidth to the -3 db point were in accord with WX-4554. However, the tube did not measure a $\frac{\lambda g}{4}$ phase shift from the unfired to the fired states, reflected in the peak power gain of +1.7 db.

The conditions of the dome-tips were observed under a microscope after 3 1/2 hours to 6 hours in the fired state. It was found that materials which are sintered and are not homogenous in cross-section have a higher sputtering coefficient than materials

which are arc-cast or drawn. The tungsten dome-tip material was made by sintering and this is the probable cause of the burrs and uneven erosion on these tubes. The rhodium dome-tip material was drawn and accounts for the lower and even erosion observed. Also it was found that a rounded rather than a flattened surface of a homogenous material has a lower sputtering coefficient.

WX-4554-11 has been set up on the traveling-wave resonant ring for the purpose of life test study. To date the tube has 68 hours of high power fired-condition time on it and only negligible changes have been noted. The antenna output pulse is still a "clean" pulse with only a slightly longer fall time (2 nsec. longer at -17 db point) than at the initial start of the life test.

G <u>SYNCHRONIZER</u>

Range Mark Generator units have been constructed for installation in two deliverable systems (one was previously constructed and installed in the Flight Test System).

Drafting is 90% finished with total rework effort on the Frequency Generator. Some partial releases for fabrication have been written covering the center section rework. Work on building and testing the breadboard unit for the F101 is continuing.

H <u>TRANSMITTER</u>

Difficulty was experienced with three major components on the flying breadboard, namely:

(1) 30 KV H_1 voltage transformer. New design made with molded coil has no failure after approximately 100 hours operation.

(2) Charging choke for C.F.A. Modulator. Two units failed. A new design was tried with a molded coil to prevent stress on

wire insulation. This unit has approximately 20 hours of operation.

(3) PFN. The PFN's have shown non-correlated operation. The relation between PFN and CFA impedance is not apparent.

To prepare the transmitter for flight test, a thermistor was installed and the overload circuit corrected to operate with the system. The pressure vessel was checked and found suitable for flight.

New waveguide and other mechanical changes were incorporated in the prototype design.

I FIELD TEST EQUIPMENT

Composite test of the System Test Set has been completed, except for graphing and photographing the detected RF pulsed signals of the Transponder Assembly. The step attenuator in the Transponder Assembly failed and has been replaced and calibrated. The new amplifier for the Pulsed RF Stability Test is now going through breadboard tests. When these tests are complete, a new amplifier will be built which is expected to solve the problem of 400 cps pickup and noise during the high gain mode of operation of the stability analyzer. System tests are hoped to get underway by 9-11-63, dependent upon availability of an operating Radar System.

J MOTION COMPENSATION

The first deliverable model including the roll platform, the operating electronics and the test unit were complete in August. The acceptance test is complete. It was found satisfactory in all respects except one interface where the antenna

position control had been designed for the wrong position pick-off. This will be corrected before delivery in September. Two items concerning the test unit do not meet the original intent of the test procedure but will remain unchanged for the present. When the Motion Compensation Unit is operated from the test unit alone, 14 kc excitation must be supplied externally. When the MCU is operated with the radar and INS, external power must be supplied to the MCU. These external power sources had not been anticipated.

K RADOME

The full radome has been measured by the supplier and found to have 94% transmissibility. This is 0.5 db two way loss which was the maximum loss measured on a partial panel at Westinghouse. Plans are being made to conduct antenna-radome tests.